UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND
TOXIC SUBSTANCES

Memorandum

DATE: June 14, 2002

SUBJECT: Biological and Economic Analysis of Diazinon on Sweet Cherries: Impacts of Cancellation

FROM: Colwell Cook, Entomologist
Herbicide and Insecticide Branch

T J Wyatt, Economist
Economic Analysis Branch
Biological and Economic Analysis Division (7503C)

THROUGH: David Brassard, Senior Entomologist
Arnet Jones Chief
Herbicide and Insecticide Branch

David Widawsky, Chief
Economic Analysis Branch

TO: John Hebert, Chemical Review Manager
Susan Lewis, Chief
Reregistration Branch 1
Special Review and Reregistration Division (7508C)

CC: Denise Keehner, Director
Biological and Economic Analysis Division

PEER REVIEW DATE: June 12, 2002

SUMMARY

Cancellation of diazinon for use on sweet cherries could have important impacts on some producers. California producers are likely to suffer the greatest impacts because their margin between costs and revenues is less than that for producers in Oregon and Washington. Impacts in California could range from \$15.70 to \$170.50 per acre, representing 6.3 to 68.1% of net revenues. In Oregon, impacts range from \$11.80 to \$152.40/acre or 2.6 to 34.1% of net revenues. Washington, where yields and prices received are highest, fares best. Impacts represent between 0.2 and 7.9% of net revenues for per-acre costs between \$9.60 and \$360.10/acre. The high values correspond to the scenario in which multiple alternatives must be used to control the suite of pests targeted by a single application of diazinon. Individually, boring beetles result in the largest per-acre costs to growers because no effective chemical alternatives exist and growers may have to remove infested trees, incurring yield losses that will be sustained over several years while new trees are established.

Regional impacts are relatively slight, despite the fact that 10 to 30% of sweet cherry acreage is treated with diazinon. BEAD calculates that losses in the three states could range from \$217,200 to \$1,490,000, representing 0.2-0.7% of total gross revenues.

LIMITATIONS AND SCOPE OF ANALYSIS

The scope of this analysis includes an examination of potential per-acre and state level impacts associated with elimination of the use of diazinon on sweet cherries. This mitigation scenario reflects the high health risks to mixers, loaders and applicators as identified by the Health Effects Division of the Office of Pesticide Programs. This analysis does not attempt to address impacts associated with mitigation efforts targeted at workers reentering fields treated with diazinon, or potential mitigation for various environmental risks (i.e., risk mitigation for risks to terrestrial plants and organisms or water contamination).

There are limitations to this assessment. The impacts estimated by this analysis only represent potential short-term, *i.e.*, one to two years, impacts on the sweet cherry production system and grower returns. Regional impacts are calculated by simply scaling up the estimated per-acre impacts. We ignore potential changes in price that may result from production changes and estimated grower impacts assume there will be no shift from sweet cherries to other crops.

Assumptions about yield and quality losses associated with the various scenarios are based on the best professional judgement of BEAD analysts when estimates were not available from other sources. Assumptions are based on a review of available USDA crop profiles, state crop production guides, discussions with university extension and research entomologists knowledgeable in sweet cherry production, and other sources listed. Cherry production is a complex system that can be influenced by a variety of parameters (e. g., weather). BEAD's ability to quantitatively capture the wide array of events that could unfold given each hypothetical scenario listed above is very limited.

CROP PRODUCTION

Sweet cherries are primarily produced in four states: California, Michigan, Oregon, and Washington. States with minor production include Idaho, Montana, New York, Pennsylvania, and Utah. Average acreage, annual production and values are provided in Table 1. Michigan and Washington also produce a significant quantity of tart cherries. Sweet cherries average about $240 million in gross revenues. About 56% of production is for the fresh market and contributes almost 80% of the value. Fresh market fruit commands a price of more than $1500/ton while processed fruit brings less than half that. The U.S. exports about 42,000 metric tons (MT) of fresh cherries annually, around 20% of total production (USDA/ERS, 2002). The export market is especially lucrative, with prices to Asia of around $2,300/ton.

Table 1. Average sweet cherry acreage, production value, 1999 to 2001

State	Bearing Acres	Production (tons)	% of Total Production	Yield (tons/acre)	Value ($1000)	Price ($/ton)
Washington	18,000	86,700	42.6	4.8	133,129	1536
California	18,300	46,800	23.0	2.6	54,648	1167
Oregon	11,000	37,000	18.2	3.4	26,617	801
Michigan	7,700	26,400	13.0	3.4	14,073	533
Other[1]	2,900	6,800	3.3	2.3	12,271	1805
Total	57,900	203,700		3.5	240,738	1182

Source: USDA/NASS (2002)

[1] Includes Idaho, Michigan, Montana, New York, Pennsylvania and Utah.

DIAZINON USE ON SWEET CHERRIES

Diazinon is a broad spectrum organophosphate. In sweet cherries it is used primarily as a dormant, delayed dormant spray, in combination with horticultural oil. Diazinon is considered the cornerstone for control of several different insect pests in sweet cherries, the most important of which are the San Jose scale, black cherry aphid, a complex of bark boring beetles and cherry fruit flies. These pests are found throughout the cherry production regions, but the most critical insect pest varies by location. For instance, in California, the primary driver for diazinon is San Jose scale, while in some areas of Washington the primary driver is the black cherry aphid and in other parts it is the bark borers. In some areas diazinon is used as a cover spray to control fruit flies.

For the period 1987-1997, BEAD (2000) had estimated that about 17% of the sweet cherry acreage, or about 8,000 acres, was treated annually with about 18,000 lbs active ingredient (a.i.). More recent data suggest a slight upward trend in usage. Table 2 presents the best available data on use in 1999 from a number of sources. Diazinon usage is particularly important in California and the Pacific Northwest, with

96% of usage by weight. Therefore, this assessment focuses on these three states.

Table 2. Diazinon usage on sweet cherries, 1999.

State	Acreage[2]	Treated Acreage	% Area Treated	lbs a.i. Applied	Rate per Year (lbs a.i./acre)
Washington	18,000	3,700	20.6	6,600	1.8
California	20,100	5,700	28.4	12,700	2.2
Oregon	11,000	1,100	10.0	1,400	1.3
Other[1]	9,000	800	9.0	900	1.1
Total	58,100	11,400	19.6	21,600	1.7

Source: USDA/NASS, 2000, California DPR, 2002, EPA data.
[1] Idaho, Michigan, Montana, New York, Pennsylvania and Utah.
[2] Includes non-bearing acreage.

Target Insects

San Jose Scale, *Quadraspidiotus perniciosus* (Comstock)

San Jose scale attacks most cultivated fruits and a large number of ornamental shrubs and trees. The scales are protected by a shell-like cover as they feed on limbs, twigs, and fruit. Crawlers emerge from beneath the shell to new feeding sites. Moderate infestations can reduce vigor and blemish fruit. High populations may seriously weaken or kill fruiting branches and main limbs, thus causing permanent injury to mature trees. Stress caused by San Jose scale can shorten the life of the tree.

Current recommendations for scales are narrow range oil applications with diazinon, endosulfan, or methidathion during the dormant season. Insecticides applied for other pests may prevent establishment of the scales in most commercial orchards during the growing season. Most states recommend alternating the chemicals to prevent insecticide resistance by the pests.

San Jose scale does have some possible alternatives. Currently registered chemicals are methidathion, endosulfan, chlorpyrifos, and carbaryl. However, states have been highly restricting endosulfan due to fish kills. Some sweet cherry operations are in riparian areas, consequently usage of endosulfan has declined in recent years. Carbaryl is not efficacious. Chlorpyrifos is phytotoxic to sweet cherries foliage and fruit and is not recommended. Therefore, methidathion is the likely alternative to diazinon.

Black Cherry Aphid, *Myzus cerasi* (F.)

The black cherry aphid is the most common aphid attacking sweet cherries. Feeding causes curling and stunting of leaves and stems. These aphids excrete large amounts of honeydew on leaves and fruits. Black sooty fungus can grow on the honeydew, making the cherries unmarketable. Heavy infestations may kill young trees and reduce crop quality and quantity on mature trees. While no thresholds have been established for mature trees, young trees cannot tolerate even low numbers of aphids. Additionally, aphids are known to develop resistance to insecticides very rapidly, especially if growers tend to use just one active ingredient.

Although usually considered a secondary pest in sweet cherries, the black cherry aphid has been known to cause significant damage. Several years ago, growers applied endosulfan and when the aphid population continued to increase, reapplied endosulfan. However, it was later determined that the aphids had developed resistance to endosulfan. That year 25% of the fruit was left unharvested because it was infested with black sooty fungus (McNeill, personal communication).

States recommend delayed-dormant applications of oil plus an organophosphate, like diazinon, to control the black cherry aphid. This combination also controls other cherry pests. Aphid natural enemies, which include syrphid flies, lacewings, and lady beetles, are often abundant enough to control this species during the growing season.

The registered alternatives to diazinon for black cherry aphid in sweet cherries are endosulfan, malathion, carbaryl and esfenvalerate. As previously mentioned endosulfan is already highly restricted; malathion and carbaryl are not very efficacious. Esfenvalerate is efficacious but causes mite population explosions since it is also efficacious against the predaceous mites. Additionally, aphids are known to develop insecticide resistance rapidly, many are already resistant to the synthetic pyrethroids like esfenvalerate. Unfortunately, we lack data to characterize the likelihood of resistance arising.

Shothole Borers: *Scolytus rugulosus* Muller, *Xyleborus dispar* Fabricius, *Xyleborus saxeseni* Ratzeburg

S. rugulosus is a bark beetle that lives between the bark and the surface of the wood, scoring the sapwood. It feeds on the tree's succulent phloem tissue. The mining of the *S. rugulosus* beetles can interfere with the movement of fluids through the cambium layer between the wood and the bark. Infested trees will be girdled and killed. *Xyleborus* spp. bore into the wood of the trees, forming galleries in which both adults and larvae live and feed on a fungus that they cultivate. The excavation and introduced fungus by *Xyleborus* beetles damage and clog the xylem, ultimately killing all or part of the plant. The damage causes stems and branches to wilt and die; this damage in apples and pears is often mistaken for fireblight. Control of these insects is crucial since they will disperse from an infested trees to the nearby healthy trees, resulting in a "ring" of dead and dying trees.

Recommendations stress sanitation and keeping trees as healthy as possible. Management strategies include burning pruned materials. If populations are high it is recommended to protect nearby trees, with applications of diazinon or endosulfan as trunk and limb sprays when the adults are active. Scouting is especially critical in orchards near residential areas because these beetles infest ornamental trees and are a likely source for infestations.

For the complex of borers, endosulfan and chlorpyrifos are registered. Again, the restrictions placed on endosulfan make it an unlikely candidate as a viable alternative. Chlorpyrifos is not recommended for this pest so we assume that it is not efficacious.

Cherry Fruit Flies: Western Cherry Fruit Fly, *Rhagoletis indifferns* Curran, Black Cherry Fruit Fly, *R. fausta* (Osten Sacken, and Cherry Fruit Fly, *R. cingulata* (Loew)

These three native species of fruit flies are very important pests of wild and cultivated cherries. The quality and market value of the crop are greatly reduced by the fruit fly maggots feeding in the flesh near the seed, often causing malformed fruit, that ripens earlier than surrounding fruit and is unmarketable. These fruit flies are major pests of cherries and control is critical, especially in the export market where there is zero tolerance.

Adults are monitored during the growing season using adhesive-covered yellow panel traps baited with a lure. Traps are used to detect the beginning of fly emergence, but they are not good indicators of the level of infestation. Management is directed against the adults because once the maggot burrows into the fruit it is protected from insecticides. The most commonly used insecticide for fruit flies is azinphos methyl (under time-limited registration, with a proposed re-entry interval (REI) of 15 days). However, diazinon is the insecticide of choice if the fruit fly pressure is low to moderate because it is perceived as less toxic and has a shorter REI (the current REI=24 hrs) than azinphos methyl.

The cherry fruit fly complex is usually controlled during the growing season with azinphos methyl or diazinon. Malathion is also registered for use on sweet cherries for this pest, but it is not efficacious in all areas or if insect pressure is high. If maggots are already in the fruit, dimethoate is recommended to keep the larvae from emerging thereby reducing future populations. Dimethoate is under reregistration at this time and should not be considered a viable alternative. Spinosad has a supplemental label for stone fruits to control fruits flies.

Today, other than the fruit flies, none of these insects is considered to be a primary pest in commercial orchards of sweet cherries. This is mainly due to the use of diazinon, and other organophosphates, in conjunction with the horticultural oil during the dormant or delayed dormant stage. The use of these products in the integrated pest management strategy that has relegated all but the fruit flies to secondary pest status. However, each of these pests have accounted for extensive damage in the past, so there is potential for these pests to cause significant damage. In addition, all these insect pests occur throughout the cherry production region so there is much overlap of the populations. The scales, aphids, and borers currently have sporadic population explosions. With the current production practices it is rare to have problems with more than one of these insect pests at a time.

IMPACT OF DIAZINON CANCELLATION ON SWEET CHERRIES

Per Acre Biological and Economic Assessment

The loss of diazinon on sweet cherries could potentially have many ramifications since it not only controls several secondary pests and a primary pest, but also because all these insect populations overlap within the entire growing region. Additionally, little efficacy data or comparative product performance data exists. This makes predicting what is likely to happen to the sweet cherry industry extremely difficult. For these reasons, in the following scenarios alternatives are considered to be of similar efficacy and no yield losses were assessed. This may or may not be true.

Crop budgets for cherry production, prepared by the University of California (Frost *et al.*, 2000), Oregon State University (Seavert *et al.*, 2002) and Washington State University Cooperative Extension programs (Hinman and Watson, 1998) form the basis for the economic analyses. These budgets reflect typical grower costs, but are not derived from survey data. They do not necessarily specify specific chemicals, but provide an estimate of total insecticide expenditures growers are likely to make. Initially, all assessments are done on a per-acre basis. The three-year averages for production, acreage and value (USDA, 2001) are used to calculate state-specific yields and prices to determine gross revenues. Net cash returns are only returns over variable production costs and do not include fixed and quasi-fixed costs such as land values and orchard establishment and therefore overstate actual returns to the grower's labor and management skills.

Table 3. Gross returns, production costs and net cash returns with treatment for San Jose Scale in California cherries.

	Base Scenario diazinon	Alternative methidathion	% change
production (tons/acre)	2.6	2.6	0.0
price ($/ton)	1166.60	1166.60	
gross returns ($/acre)	3033.00	3033.00	
diazinon ($/acre) methidathion ($/acre)	14.80	30.48	105.9
other insecticide costs ($/acre)	48.00	48.00	
total insecticide costs	63.00	78.00	25.0
other pre-harvest costs ($/acre)	1239.00	1239.00	
harvest costs ($/acre)	1481.00	1481.00	
total operating costs ($/acre)	2783.00	2798.00	0.6
net cash returns ($/acre)	250.00	235.00	-6.3

Source: University of California Cooperative Extension (2000), BEAD data.
Totals may differ from sum of components due to rounding.

Scenario 1. San Jose Scale. BEAD believes that growers that apply diazinon to control San Jose scale will chose to use methidathion. There should be no yield or quality loss with this selection. Table 3 shows gross revenues and production costs in California comparing the base scenario for an acre on which diazinon is used to the alternative use of methidathion. Yields are approximately 2.6 tons/acre in California (USDA, 2001) and the weighted average price for fresh market and processed cherries is about $1167/ton. Gross revenues per acre are over $3,030. According to EPA data, an application of diazinon targeting San Jose Scale costs an average of $14.80/acre. The average cost of an application of methidathion is $30.48/acre, more than twice the cost of diazinon. Overall, this results in a 25% increase in insecticide costs and a 0.6% increase in total operating costs. Net revenues in the base scenario are about $250/acre. They fall 6.3% in the alternative case, to $235/acre.

Table A1, in the appendix, provides similar figures for Oregon and Washington. Yields in Oregon are higher than in California, but Oregon growers receive a lower average price for their produce resulting in somewhat lower gross revenues of about $2,720/acre. High yields and high prices in Washington make cherry production there more lucrative at almost $7,400/acre. Treatment costs rise by over $12/acre in Oregon and just under $10/acre in Washington. These changes in cost result in a 2.7% decline in net revenues in Oregon and a 0.2% decline in Washington.

Scenario 2. Black Cherry Aphid. BEAD predicts that growers will likely use esfenvalerate, plus at least one additional application of a miticide to control the outbreak of mites after application. But a possible scenario, based on previous experience with endosulfan resistant black cherry, if esfenvalerate resistant aphids are present, growers could experience a 25% loss. Table 4 provides budget figures for California. Diazinon applications aimed at aphids are somewhat lighter (1.3 lbs a.i./acre, on average) than those aimed at scale (1.6 lbs a.i./acre), so application costs are lower. Esfenvalerate is more than $3.00/acre cheaper than diazinon, but kills predatory mites that form a biological control on damaging mites, thus requiring an application of an additional miticide. Average miticide costs in California are nearly $30.00/acre, leading to an overall increase in insecticide costs of 44%. Net returns fall by over $25.00/acre or a decline of 10.4%. If esfenvalerate is the only aphicide used, it is likely that the insects will develop resistance. A grower facing aphids resistant to synthetic pyrethroids like esfenvalerate could face devastating losses as a result of unharvestable fruit.

Tables A2 and A3 provide the same information for aphid control in Oregon and Washington. Impacts are less severe in the Pacific Northwest due to somewhat more favorable insecticide costs and higher gross returns. In Oregon, this analysis suggests additional costs of less than $12.00/acre resulting in a 2.6% drop in net revenues. Additional insecticide costs are almost $14.00/acre in Washington, with a 0.3% decline in net revenues. However, if a grower faces aphids resistant to esfenvalerate, he or she could incur losses in net revenues as high as $360/acre in Oregon and $1,460/acre in Washington. These losses are driven by damage resulting in unharvestable fruit.

Scenario 3. Boring Beetles. Dr. Smith (personal communication) reports that about 3,000 acres of sweet cherries in Washington are currently infested with boring beetles. Young trees can be killed directly and older trees can be weakened and die indirectly by not making it through the winter or from pathogens.

Estimates of losses from the wood boring beetle complex could be that 5-10% of the acres could lose trees. Some growers may apply chlorpyrifos to salvage some of their trees even though it is much less effective. For this scenario, BEAD assumes growers are more likely to cut down infested trees and any surrounding trees to stop the beetles from spreading, perhaps up to 10 trees will be removed.

Table 4. Gross returns, production costs and net cash returns with treatment for Black Cherry Aphids in California cherries.

	Base Scenario diazinon	No Resistance		Resistance	
		Alternative esfenvalerate + miticide	% change	Alternative esfenvalerate + miticide	% change
production (tons/acre)	2.6	2.6	0.0	2.0	-25.0
price ($/ton)	1166.60	1166.60		1166.60	
gross returns ($/acre)	3033.10	3033.10	0.0	2274.80	-25.0
diazinon ($/acre) esfenvalerate ($/acre)	12.03	8.84	-26.5	8.84	-26.5
other insecticide costs ($/acre)	48.00	77.63	161.7	77.63	161.7
total insecticide costs	60.03	86.47	44.1	86.47	44.1
other pre-harvest costs ($/acre)	1238.50	1238.50		1238.50	
harvest costs ($/acre)	1481.30	1481.30		1111.00	-25.0
total operating costs ($/acre)	2779.83	2806.27	1.0	2436.97	-12.4
net cash returns ($/acre)	253.27	226.83	-10.4	-162.17	-163.6

Source: University of California Cooperative Extension (2000), BEAD data.
Totals may differ from sum of components due to rounding.

Orchard density varies widely and more recent recommendations include high-density plantings. We assume the typical orchard is about 200 trees per acre; thus removing 10 trees would result in a five (5) percent loss of yields. More densely planted orchards may just permit more rapid infestation of beetles, so the five percent loss could be applicable across the range of densities. In this scenario, growers forego the application of diazinon, however they incur additional labor costs in the removal of infested trees. For lack of specific data, we assume five hours of work to fell, remove and burn the infested trees. Further, removing the trees implies that yield losses would be incurred in subsequent years, until new trees could be established and begin to bear fruit.

Table 5 provides figures for this scenario for California cherry producers. A five percent yield loss translates into losses of gross revenues of over $150/acre. Diazinon is applied at an average rate of over 1.5 lbs a.i./acre for this pest complex, resulting in treatment costs of over $14.00/acre. The grower would save the money spent on this application, reducing insecticide costs by about 23%. The additional labor costs incurred from cutting and burning infested and surrounding trees increases operating costs by almost 4%. Harvest costs decline so that total operating costs decrease by about 1.5%. Net returns drop by about $110/acre, or a decline of 43.9%.

Table 5. Gross returns, production costs and net cash returns with treatment for Shot-hole Borers in California cherries.

	Base Scenario diazinon	Alternative cutting/burning	% change
production (tons/acre)	2.6	2.5	-5.0
price ($/ton)	1166.60	1166.60	
gross returns ($/acre)	3033.00	2881.00	-5.0
diazinon ($/acre)	14.43		-100
other insecticide costs ($/acre)	48.00	48.00	
total insecticide costs	62.00	48.00	-23.1
other pre-harvest costs ($/acre)	1239.00	1286.00	3.8
harvest costs ($/acre)	1481.00	1407.00	-5.0
total operating costs ($/acre)	2782.00	2741.00	-1.5
net cash returns ($/acre)	251.00	141.00	-43.9

Source: University of California Cooperative Extension (2000), BEAD data.
Totals may differ from sum of components due to rounding.

Table A4 (see appendix) provides the analysis for Oregon and Washington. Gross revenue losses are about $140/acre in Oregon and $370/acre in Washington. Insecticide costs and harvest costs both decline, but labor costs increase. The overall result is that total operating costs decrease by about 1.2% in Oregon and about 2% in Washington. Net revenues decline by about $110/acre in Oregon or nearly 25%. In Washington, losses in net revenue could be around $310/acre or almost 7%. Again, these analyses do not include yield losses in subsequent years and reestablishment costs that would reduce the long-term profitability of the orchard.

Scenario 4. Fruit Flies. Growers currently applying diazinon for the fruit fly complex would likely chose spinosad for the summer sprays. Other chemicals often used for controlling fruit flies such as azinphos methyl, dimethoate and malathion are already cheaper than diazinon. Therefore, BEAD believes that growers using diazinon do so because these other chemicals are inappropriate for their production system due to pest pressure, concerns over the environment or worker safety, or label restrictions. (If no further restrictions are placed on diazinon, more growers may turn to it due to restrictions on azinphos methyl.) Spinosad would likely be applied since it is less toxic than other alternatives and has an REI of 4 hours and a PHI of 7 days.

Table 6 provides budget figures for California and Oregon. Control of fruit flies may require multiple applications during the growing season. In our scenario, we assume two sprays with diazinon of about 1 lb a.i./acre each replaced with two sprays of spinosad at about 0.1 lb a.i./acre each. Spinosad is considerably more expensive than diazinon, increasing fruit fly control by about $40/acre in California and over $50/acre in Oregon. Decreases in net returns are about 16.8% in California and 12.2% in Oregon.

Table 6. Gross returns, production costs and net cash returns with treatment for Fruit Flies in California and Oregon cherries.

	California			Oregon		
	Base Scenario diazinon	Alternative spinosad	% change	Base Scenario diazinon	Alternative spinosad	% change
production (tons/acre)	2.6	2.6	0.0	3.4	3.4	0.0
price ($/ton)	1166.60	1166.60		800.50	800.50	
gross returns ($/acre)	3033.00	3033.00		2722.00	2722.00	
diazinon ($/acre) spinosad ($/acre)	18.50	59.90	223.8	12.32	66.78	442.0
other insecticide costs ($/acre)	48.00	48.00		111.00	111.00	
total insecticide costs	67.00	108.00	62.3	123.00	177.00	44.3
other pre-harvest costs ($/acre)	1239.00	1239.00		802.00	802.00	
harvest costs ($/acre)	1481.00	1481.00		1351.00	1351.00	
total operating costs ($/acre)	2786.00	2828.00	1.5	2276.00	2331.00	2.4
net cash returns ($/acre)	247.00	205.00	-16.8	446.00	391.00	-12.2

Source: UC Cooperative Extension (2000), OSU Cooperative Extension (2002), BEAD data.
Totals may differ from sum of components due to rounding.

The impact of cancelling diazinon in Washington is shown in the appendix, Table A5. Comparative figures show that diazinon is used at a rate of 1.5 lbs a.i./acre/application while spinosad is applied at about 0.75

lbs a.i./acre. The cost difference in Washington is less than in California and Oregon. Switching to spinosad would cost growers currently using diazinon about $26.00/acre more. The resulting decrease in income only represents about 0.6% of net returns.

Scenario 5. All insects occurring simultaneously. Between dormant sprays and summer sprays, losses would essentially be additive. However, for the total pest complex targeted by a dormant season application of diazinon, growers could find it necessary to apply methidathion, esfenvalerate and a miticide, and cut and burn some trees. Table 7 shows the potential impacts for California and Oregon when all dormant season pests are present.

Table 7. Gross returns, production costs and net cash returns with treatment for all dormant season pests in California and Oregon cherries.

	California			Oregon		
	Base Scenario diazinon	Alternative methidathion esfenvalerate + miticide cutting/burning	% change	Base Scenario diazinon	Alternative methidathion esfenvalerate + miticide cutting/burning	% change
production (tons/acre)	2.6	2.5	-5.0	3.4	3.2	-5.0
price ($/ton)	1166.60	1166.60		800.50	800.50	
gross returns ($/acre)	3033.00	2881.00		2722.00	2586.00	-5.0
diazinon ($/acre) methidathion ($/acre) esfenvalerate ($/acre)	14.80	 22.26 8.84	 110.1	11.20	 20.00 9.36	 162.1
other insecticide costs ($/acre)	48.00	78.00	161.7	111.00	124.00	12.3
total insecticide costs	63.00	109.00	73.1	122.00	154.00	26.1
other pre-harvest costs ($/acre)	1239.00	1286.00	3.8	802.00	852.00	6.2
harvest costs ($/acre)	1481.00	1407.00	-5.0	1351.00	1286.00	-4.8
total operating costs ($/acre)	2783.00	2802.00	0.7	2275.00	2291.00	0.7
net cash returns ($/acre)	250.50	80.00	-68.1	447.00	294.00	-34.1

Source: UC Cooperative Extension (2000), OSU Cooperative Extension (2002), BEAD data.
Totals may differ from sum of components due to rounding.

If growers must apply two chemicals to replace a single application of diazinon, control costs will more than double. The additional requirement of a miticide implies that total insecticide costs could increase by 73% in California and 26% in Oregon. Labor costs associated with control of boring beetles and yield losses that could occur suggest an increase in total operation costs of about 0.7% for both states. This is including the reduced harvest costs that result from removing beetle-infested trees. Net revenues could decline by 68% in California and by about one-third in Oregon.

Washington growers would face higher absolute losses, but higher yields and prices mean that they are more able to absorb these losses. Results from the budget analysis for Washington are shown in Table A6, in the appendix. Insecticide costs rise by almost 30% and labor costs by 3%. Reductions in harvest costs, however, imply that total operating costs decrease slightly. Yield losses are primarily responsible for the decline in net revenues of 7.9%.

Regional Level Economic Assessment

Extrapolation of per-acre impacts to the state or regional level is fraught with difficulties and especially so when multiple pests requiring different treatments are implied. Since the pest complex exists throughout the growing region, even if BEAD were able to identify the specific target pest driving an application of diazinon, it does not necessarily follow that a single replacement would ultimately insure sufficient control of the whole complex.

However, some data exist on which to base an assessment. Total area treated with diazinon is shown in Table 2. EPA data provide a breakdown of area treated by primary target pest. Table 8 provides the estimated regional level impacts based on individual pest and area. Because diazinon is a very broad spectrum insecticide and is used on a number of pests not considered in this assessment, the total area treated with diazinon (Table 2) exceeds the total area impacted in Table 8. Thus, Table 8 might be considered a lower bound on potential impacts as it does not consider all target pests and assumes that the primary pest is the sole pest that requires control.

For California, scale is the primary pest with little or no area treated for fruit flies. About 4,600 acres could be impacted with total costs of cancellation around $104,000 out of total gross revenues of $54.6 million

Table 8. Regional level impacts of diazinon cancellation for use on sweet cherries, individual pest assessment.

	Scale	Aphids	Borers	Fruit Flies	Total
California					
area impacted	3,200	1,200	200	-	4,600
cost/acre[1]	15.70	26.50	110.20	41.40	22.60
total cost	50,200	31,800	22,000	-	104,000
Oregon					
area impacted	-	200	-	300	500
cost/acre[1]	12.20	11.80	109.40	54.50	36.80
total cost	-	2,400	-	16,000	18,400
Washington					
area impacted	1,400	200	100	1,800	3,500
cost/acre[1]	9.60	13.90	311.00	26.40	27.10
total cost	13,400	2,800	31,100	47,500	94,800
Region					
area impacted	4,600	1,600	300	2,100	8,600
cost/acre	13.80	23.10	177.00	30.40	25.30
total cost	63,600	37,000	53,100	63,900	217,200

Source: EPA data, BEAD calculations.

[1] Cost/acre for individual pests is the difference between net cash returns in the base and alternative scenarios calculated above.

or 0.2%. In Oregon, specific target pests are aphids and fruit flies for a combined area of impact of 500 acres and costs of $18,400. Gross revenues in Oregon total $26.6 million so losses represent less than 0.1%. Fruit flies and scale are the main drivers of diazinon use in Washington, where a total of 3,500 acres could be affected. Costs could total around $94,000 annually, out of gross revenues of $133.1 million, or less than 0.1%. For the entire region, 8,600 acres could be affected and the total cost of cancellation could be around $217,200, about 0.1% of gross revenues that total about $214.4 million.

If we assume, however, that dormant season applications of diazinon targeting a specific pest actually averts damage from the entire dormant season pest complex of scales, aphids and borers, then an upper bound on the impacts might be estimated by utilizing the estimated losses incurred from control of all the pests. Table 9 provides these figures. Costs are significantly higher assuming the entire pest complex. California cherry growers could face losses of $784,300 or 1.4% of gross revenues. For Oregon, the equivalent numbers are $46,400 or almost 0.2% of gross revenues, and Washington growers could incur losses of $659,700 or 0.5% of the gross value of production. Upper bound losses for the region are $1,490,900, which is about 0.7% of total gross revenues.

Neither assessment considers the impact of borer pests on the long-term profitability of the orchard where tree removal will result in yield losses for several years and the grower will incur reestablishment costs. Nor do these figures include the potential for aphid resistance to synthetic pyrethroids that could result in extensive yield losses, albeit on a small number of acres. Further, this assessment ignores small but potentially important usage of diazinon in cherry production of other states, including Michigan and Idaho, and the benefits that these states derive from diazinon availability.

CONCLUSION

Diazinon is a broad-spectrum insecticide that is used during the dormant and delayed dormant season to control a number of secondary pests that have the potential to cause severe injury to sweet cherry trees. No single pesticide can achieve control of all these pests and the costs of alternative measures depends on the number of pests the grower will have to control. On average, costs could range from $13.80/acre for scale to $177.00/acre for borers, which includes yield losses, if only single pests are targeted. If the entire pest complex must be controlled, costs could be as much as $220/acre. Diazinon is also used for the control of fruit flies, a major pest for which azinphos-methyl is a common insecticide. Growers use diazinon, despite higher costs, because of shorter re-entry and pre-harvest intervals and because it is viewed as less toxic. The likely alternative, spinosad, could add about $30/acre to the growers' production costs. California growers are likely to be especially hard hit because their margin is lower than in Oregon and Washington.

Table 9. Regional level impacts of diazinon cancellation for use on sweet cherries, dormant season pest complex assessment.

	Dormant season complex	Fruit flies	Total
California			
area impacted	4,600	-	4,600
cost/acre[1]	170.50	41.40	-
total cost	784,300	170.50	784,300
Oregon			
area impacted	200	300	500
cost/acre[1]	152.40	54.50	92.80
total cost	30,500	16,400	46,400
Washington			
area impacted	1,700	1,800	3,500
cost/acre[1]	360.10	26.40	188.50
total cost	612,200	47,500	659,700
Region			
area impacted	6,500	2,100	8,600
cost/acre	219.50	30.40	173.40
total cost	1,427,000	63,900	1,490,900

Source: EPA data, BEAD calculations.

1 Cost/acre for individual pests is the difference between net cash returns in the base and alternative scenarios calculated above.

Industry impacts are difficult to assess because of the complex mixture of pests involved. BEAD estimates that costs for the region consisting of California, Oregon and Washington could range from $217,200 to $1,490,000, representing 0.1-0.7% of total gross revenues. However, these figures do not include losses that may arise with pyrethroid-resistant aphids or the long-term impact of yield losses associated with borer pests. Some losses will also accrue to other producing states such as Michigan and Idaho, where diazinon usage is relatively minor.

REFERENCES

Beers, E. H., J. F. Brunner, M. J. Willet, and G. M. Warner, eds. 1993. Orchard Pest Management: A Resource Book for the Pacific Northwest. Good Fruit Grower, Yakima, WA.

Frost, W., K. Klonsky and R. DeMoura. 2000. *Sample costs to produce sweet cherries, Sierra Nevada foothills*, University of California Cooperative Extension, Davis, California.

Hinman, H., and J. Watson. 1998. *Cost of establishing and producing sweet cherries in central Washington in 1998*, Washington State University Cooperative Extension.

Hirnyck, Ronda. Pesticide Programs. University of Idaho–Boise. Personal communication with Colwell Cook, May 24 and 31, 2002.

McGrath, Daniel, ed. 2001. Pacific Northwest 2001 Insect Management Handbook. Oregon State University.

McNeill, Shawn. WA Tree Fruit Research Commission. Personal communication with Colwell Cook. May 8, 2002.

Pearson, Al. 2001. Georgia Commodity Commission for Peaches, Chair. Letter to Diane Isbell for support of phosmet, March 2, 2001.

Seavert, C., M. White and L. Long. 2002. *Orchard economics: Establishing and producing standard- and high-density sweet cherries in Wasco County*, Oregon State University Extension Service.

Smith, Tim. Washington State University. Personal communication with Colwell Cook. May 8, 2002.

USDA. 2000. Crop Profile for Cherries in Virginia. Prepared April 2000.

USDA. 1999. Crop Profile for Cherries (Sweet) in Oregon. Prepared July 1999.

USDA, Economic Research Service (ERS). 2002. Foreign Agricultural Trade of the United States (FATUS), 1999/2000 calendar years, at www.ers.usda.gov/db/fatus.

USDA, National Agricultural Statistics Service (NASS). 2002. *Noncitrus Fruits and Nuts, 2000 Summary*, July 2001.

Washington State University. 2002. *Crop Protection Guide for Tree Fruits in Washington*. Washington State University Cooperative Extension Publication EB0419.

APPENDIX TABLES

Table A1. Gross returns, production costs and net cash returns with treatment for San Jose Scale in Oregon and Washington cherries.

	Oregon			Washington		
	Base Scenario diazinon	Alternative methidathion	% change	Base Scenario diazinon	Alternative methidathion	% change
production (tons/acre)	3.4	3.4	0.0	4.8	4.8	0.0
price ($/ton)	800.50	800.50		1536.10	1536.10	
gross returns	2722.00	2722.00		7373.00	7373.00	
diazinon	7.84			13.37		
methidathion		20.00	155.1		22.94	71.6
other insecticide costs	111.00	111.00		115.00	115.00	
total insecticide costs	119.00	131.00	10.3	128.00	138.00	7.5
other pre-harvest costs	802.00	802.00		1114.00	1114.00	
harvest costs	1351.00	1351.00		1584.00	1584.00	
total operating costs	2272.00	2284.00	0.5	2826.00	2836.00	0.3
net cash returns	450.00	438.00	-2.7	4547.00	4537.00	-0.2

Source: OSU Cooperative Extension (2002), WSU Cooperative Extension (1998), BEAD data.
All figures are denominated in $/acre, unless otherwise noted. Totals may differ from sum of components due to rounding. See page 8 of text for discussion.

Table A2. Gross returns, production costs and net cash returns with treatment for Black Cherry Aphids in Oregon cherries.

	Base Scenario diazinon	No Resistance		Resistance	
		Alternative esfenvalerate + miticide	% change	Alternative esfenvalerate + miticide	% change
production (tons/acre)	3.4	3.4	0.0	2.6	-25.0
price ($/ton)	800.50	800.50		800.50	
gross returns	2721.70	2721.70		2041.30	-25.0
diazinon	11.20				
esfenvalerate		9.36	-16.4	9.36	-16.4
other insecticide costs	110.66	124.32	12.3	124.32	12.3
total insecticide costs	121.86	133.68	9.7	133.68	9.7
other pre-harvest costs	801.60	801.60		801.60	
harvest costs	1351.50	1351.50		1024.10	-24.2
total operating costs	2274.96	2286.78	0.5	1959.38	-13.9
net cash returns	446.74	434.92	-2.6	81.92	-81.7

Source: Oregon State University Cooperative Extension (2002), BEAD data.
All figures are denominated in $/acre, unless otherwise noted. Totals may differ from sum of components due to rounding. See page 8 of text for discussion.

Table A3. Gross returns, production costs and net cash returns with treatment for Black Cherry Aphids in Washington cherries.

	Base Scenario diazinon	No Resistance		Resistance	
		Alternative esfenvalerate + miticide	% change	Alternative esfenvalerate + miticide	% change
production (tons/acre)	4.8	4.8	0.0	3.6	-25.0
price ($/ton)	1536.10	1536.10		1536.10	
gross returns	7373.10	7373.10		5529.85	-25.0
diazinon esfenvalerate	12.15	14.10	16.0	14.10	16.0
other insecticide costs	114.64	126.58	10.4	126.58	10.4
total insecticide costs	126.79	140.68	11.0	140.68	11.0
other pre-harvest costs	1114.35	1114.35		1114.35	
harvest costs	1584.00	1584.00		1188.00	-25.0
total operating costs	2825.14	2839.03	0.5	2443.03	-13.5
net cash returns	4547.96	4534.07	-0.3	3086.82	-32.1

Source: Washington State University Cooperative Extension (1998), BEAD data.
All figures are denominated in $/acre, unless otherwise noted. Totals may differ from sum of components due to rounding. See page 8 of text for discussion.

Table A4. Gross returns, production costs and net cash returns with treatment for Shot-hole Borers in Oregon and Washington cherries.

	Oregon			Washington		
	Base Scenario diazinon	Alternative cutting & burning	% change	Base Scenario diazinon	Alternative cutting & burning	% change
production (tons/acre)	3.4	3.2	-5.0	4.8	4.6	-5.0
price ($/ton)	800.50	800.50		1536.10	1536.10	
gross returns	2722.00	2586.00	-5.0	7373.00	7004.00	-5.0
diazinon methidathion	11.20		-100	13.50		-100
other insecticide costs	111.00	111.00		115.00	115.00	
total insecticide costs	122.00	111.00	-9.2	128.00	115.00	-10.5
other pre-harvest costs	802.00	852.00	6.2	1114.00	1149.00	3.1
harvest costs	1351.00	1286.00	-4.8	1584.00	1505.00	-5.0
total operating costs	2275.00	2248.00	-1.2	2826.00	2769.00	-2.0
net cash returns	447.00	337.00	-24.5	4547.00	4236.00	-6.8

Source: OSU Cooperative Extension (2002), WSU Cooperative Extension (1998), BEAD data.
All figures are denominated in $/acre, unless otherwise noted. Totals may differ from sum of components due to rounding. See page 10 of text for discussion.

Table A5. Gross returns, production costs and net cash returns with treatment for Fruit Flies in Washington cherries.

	Base Scenario diazinon	Alternative spinosad	% change
production (tons/acre)	4.8	4.8	0.0
price ($/ton)	1536.10	1536.10	
gross returns	7373.00	7373.00	
diazinon	24.30		
spinosad		50.67	108.5
other insecticide costs	115.00	115.00	
total insecticide costs	139.00	165.00	19.0
other pre-harvest costs	1114.00	1114.00	
harvest costs	1584.00	1584.00	
total operating costs	2837.00	2864.00	0.9
net cash returns	4536.00	4509.00	-0.6

Source: Washington State University Cooperative Extension (1998), BEAD data.
All figures are denominated in $/acre, unless otherwise noted. Totals may differ from sum of components due to rounding. See page 11 of text for discussion.

Table A6. Gross returns, production costs and net cash returns with treatment for all dormant season pests in Washington cherries.

	Base Scenario diazinon	Alternative methidathion esfenvalerate + miticide cutting/burning	% change
production (tons/acre)	4.8	4.6	-5.0
price ($/ton)	1536.10	1536.10	
gross returns	7373.00	7004.00	-5.0
diazinon methidathion esfenvalerate	13.37	 22.94 14.10	 177.0
other insecticide costs	115.00	127.00	10.4
total insecticide costs	128.00	164.00	27.8
other pre-harvest costs	1114.00	1149.00	3.1
harvest costs	1584.00	1505.00	-5.0
total operating costs	2826.00	2818.00	-0.3
net cash returns	4547.00	4187.00	-7.9

Source: Washington State University Cooperative Extension (1998), BEAD data.
All figures are denominated in $/acre, unless otherwise noted. Totals may differ from sum of components due to rounding. See page 12 of text for discussion.